

## SEM CARRIER SYSTEM

Four basic engineering subsystems comprise the SEM Carrier System. These are the **GET AWAY SPECIAL** ( GAS ) Canister Assembly, the **SEM Support Structure**, the **SEM Power Subsystem**, and the **SEM Experiment Module**. Each of these subsystems are described in detail in the following paragraphs.

The **GAS Canister Assembly** is a cylindrical housing used to support payloads in the Space Shuttle Cargo Bay. NASA has an entire fleet of GAS Canister Assemblies which are used to fly a wide variety of scientific payloads. GAS Canister Assemblies are available in both 2.5 and 5.0 cubic foot sizes. The Gas Canister Assembly used as part of the SEM Carrier System is the 5.0 cubic foot size which is designed to hold up to 200 pounds of internal apparatus in a volume 19.75 inches in diameter by 28.25 inches in height.

The basic layout of the GAS Canister Assembly is that of an open-ended aluminum Canister with circular aluminum Upper and Lower End Plates. A set of GAS Brackets are used to attach the Canister within the Shuttle Cargo Bay, either on the Bay sidewall or on an across-the-Bay bridge structure. Electrical cables connect the GAS Lower End Plate to the Shuttle Astronaut cabin and provide for GAS experiment activation via command signals sent by the astronauts. The inboard surface of the GAS Upper End Plate provides the mounting surface for internal contents. The GAS Upper End Plate also has two 15 psi pressure relief valves and a battery vent port to control pressure buildup within the Canister or within any internal battery boxes.

The GAS Canister Assembly provides overall structural containment for the SEM payload as well as the attachment capability within the Space Shuttle Cargo Bay. The SEM Carrier System utilizes a *standard, sealed, 5 cubic foot* GAS Canister Assembly, internally pressurized and sealed to one (1) atmosphere with dry nitrogen before launch. Prior to installation into the Space Shuttle Cargo Bay, both the Upper and Lower End Plates are covered with GAS Thermal Insulating End Caps and the entire GAS canister is wrapped with GAS Thermal Blankets to assist in passive thermal control of the canister during spaceflight.

**The SEM Support Structure** is the structural backbone for the SEM subsystems housed within the GAS canister. It serves as the mounting frame for the Power Subsystem components and the ten Experiment Modules. Five basic components comprise the **Support Structure**; the **Mounting Deck, Battery Deck, Main Bulkhead, two Stiffener Panels, and four Lateral Support Bumper Assemblies**. All of the Support Structure components are fabricated from aluminum and interconnected with steel fasteners.

Power is supplied to the experiments by the SEM Carrier System by means of the **Power Subsystem**. The subsystem is comprised of the **Battery Box, Fuse Box, and Power Harness**. Both the Battery Box and Fuse Box are mounted on the Battery Deck.

The Battery Box is a machined aluminum box which houses eight Eagle Pitcher Silver - Zinc battery cells responsible for the power generation within the SEM Carrier System. The battery cells generate 12 volts DC power, 5 Amps peak maximum. The entire Battery Box Assembly weighs 32 pounds. The overall dimensions are approximately 17.0 inches by 8.0 inches by 5.0 inches.

The Battery Vent Assembly consists of two sealed stainless steel vent lines running from the Battery Box to the vent port on the GAS Upper End Plate. Connection of the Vent Assembly to the GAS Upper End Plate is via the standard GAS Battery Vent Turret Assembly.

The Fuse Box is a machined aluminum box which contains the fuses for the SEM Carrier System.

The Power Harness is a system of cables which connects the Battery Box to the Fuse Box, the Fuse Box to each of the Modules, and the Battery Box to the standard GAS Lower End Plate interface electronics. Power will be turned on near the beginning of the mission and turned off near the end of the mission by the Astronauts using the standard GAS electronics.

The **Experiment Module Subsystem** of the SEM Carrier System has been designed as a generic housing to contain small ( 6 pound limit) experiments designed and constructed by students. Each Module is comprised of a Frame, Electronics Bracket, Bottom, Cover, and Emblem Mount. The overall Module size is approximately 17.0 inches by 10.0 inches by 3.5 inches. All Module structural elements are fabricated from aluminum and interconnected with #6 steel fasteners. Each Module is also equipped with silicone gaskets and a pressure relief diaphragm. The gaskets are designed to resist liquid leaks into or out of the individual modules. The pressure relief diaphragm is designed to release pressure from within individual modules in the event of an inadvertent pressure buildup from experiment operations. A total of ten Experiment Modules are mounted to the main bulkhead of the SEM Support Structure. Attachment of each Module to the Support Structure occurs at four mount locations on the Module flanges. Four #8 steel fasteners are used at this interface.

Each Experiment Module is divided into an experiment compartment and an electronics compartment. The experiment compartment is approximately 300 cubic inches of free space available for student experiment apparatus. The electronics compartment is reserved space for the Module Electronics Unit (MEU), which provides for power delivery, pre-programmed sequencing of the experiment operation, data acquisition, and storage of experiment data.

Experiments may be contained inside of the Modules by one of two methods. The first method of experiment containment uses NASA provided “**Space Capsules**” to enclose test articles. The Space Capsules are clear, sealable polycarbonate vials 1.0 inch in diameter and 3.0 inches in depth. A total of twenty-two Space Capsules may be packed in an individual Experiment Module using silicone foam cushions fabricated at NASA specifically for the SEM program. The Space Capsules are sent to the student experimenter from NASA once they are selected to participate in the hardware phase of the SEM program.

It is the experimenters responsibility to insert their test articles into the Space Capsules, tighten the Capsule lids, and send the Capsules back to NASA for integration into the SEM Carrier System.

The second method of experiment containment utilizes the Module Cover as an **Experiment Mounting Plate**. The free space available for experiment apparatus in the Module experiment compartment, termed the “**Experiment Envelope**,” is a precisely defined volume delineated on the inboard surface of the Experiment Mounting Plate and extending 3.25 inches below the inboard surface of the Mounting Plate. Experiments are mounted to the inboard surface of the Experiment Mounting Plate using integration hardware (screws, nuts, and washers) supplied to the experimenter by NASA. The Experiment Mounting Plate and experiment integration hardware are sent to the student experimenter from NASA once they are selected to participate in the hardware phase of the SEM program.

It is the experimenters responsibility to drill into the Experiment Mounting Plate, attach the experiment using the NASA provided integration hardware, and send the experiment back to NASA for integration into the SEM Carrier System.

Student built experiments are classified in the SEM program as either “Passive” or “Active ” experiments. A **Passive Experiment** *does not* use the MEU and therefore does not use power or record data.

**Active Experiments** are experiments which utilize the power, command, and data recording capabilities provided by the MEU. Active experiments must include (as part of the experiment) the electrical wiring which connects experiment components to the Module MEU. Active experiments may choose to monitor temperature profiles within individual Experiment Modules using NASA provided thermistors. Thermistors are small temperature sensors which can be mounted directly to experiment components using an adhesive. The thermistors are wired to the MEU as part of the experiment electrical wiring.

The Module **Emblem Mounts** are designed to attach to the exterior of each Experiment Module and provide the mounting surface for experiment emblems or decals. Emblem Mounts are sent to the student experimenters from NASA once they are selected to participate in the hardware phase of the SEM program.

If an emblem is desired, it is the experimenters responsibility to design and manufacture their experiment emblem, attach the emblem to the NASA provided Emblem Mount, and send the Emblem Mount back to NASA for integration into the SEM Experiment Module.

## **STUDENT PARTICIPATION**

Three levels of participation by students are anticipated; the design phase, the hardware phase, and the flight phase.

### **DESIGN PHASE**

In the **design phase**, experimenters perform a paper design of an experiment. NASA supplied documentation and an electronic data base will provide support to this activity including design guidelines, examples, tips, etc. The NASA supplied software running in an experimenter supplied computer will prompt the experimenter to “fill-in-the-blanks” in the Experiment Data File (EDF). The EDF will document information describing the experimenters and experiment including addresses, phone numbers, purpose, method, components, parts, materials, etc. The EDF will also document the experimenter's scenario or timeline for sending control commands from the module electronics to the experiment apparatus and for sampling and recording experiment data such as temperatures, pressures, etc.

The supplied software will provide for printing the experimenter information on a printer for making reports or papers. The printed EDF report will form the basis for an application to the hardware phase.

The software and documentation can be widely distributed allowing any number of participants in the design phase.

### **HARDWARE PHASE**

Experiments are selected to participate in the SEM Hardware Phase based on the design created in the Design Phase. Participants selected for the **hardware phase** will receive a package of hardware from NASA to support the construction and development of the selected experiment. The contents of the package depends on the proposed experiment design.

Experimenters with designs using the NASA Experiment Mounting Plate to mount experiment components receive a package including the Experiment Mounting Plate, Integration Hardware (screws, nuts and washers) as specified in the selected design, Integration Instructions, and an Emblem Mount.

It is the experimenters responsibility to drill into the Experiment Mounting Plate and attach the experiment using the NASA provided integration hardware.
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Experimenters with designs using the NASA Space Capsules receive a package including the number of Space Capsules specified in the selected design, Instructions, and an Emblem Mount. Experimenters proposing to use the Space Capsules packaged in the NASA foam cushions will receive 22 Capsules in their package.

It is the experimenters responsibility to insert their test articles into the Space Capsules and tighten the Capsule lids.
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Experimenters with designs requiring power, command, or data recording receive a package including the SEM Ground Module Electronics Unit (GMEU). The GMEU contains the identical electronics as the MEU.

It is the experimenters responsibility to include (as part of the experiment) the electrical wiring which connects experiment components to the Module MEU.
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The experiment hardware is then connected to the GMEU which will simulate the functions of the flight MEU. Trial runs of the experiment can then be conducted according to the chosen timeline. Experiment data from the trial runs is recorded in a Measurement Data File (MDF) on the experimenter's computer and

can be printed or plotted using the supplied software. The electronic or paper version of the experimenter's report from the hardware phase is used as part of an application for the flight phase.

Experimenters with designs using the NASA provided thermistors receive a package including the number of thermistors specified in the selected design.

It is the experimenters responsibility to mount the thermisters to the experiment components and incorporate the thermistor wires into the experiment wiring to the MEU interface.

## **FLIGHT PHASE**

Experimenters selected for participation in the **flight phase** will submit their experiments, emblem mounts and data files (if applicable) to NASA/SSPP to be installed in modules. Experiments using the NASA Experiment Mounting Plate send their experiments to NASA mounted on the Mounting Plate. Experiments using only the Space Capsules will send NASA the Capsules with the test articles enclosed. The GMEU, if used, must also be returned to NASA. The timeline data in the experimenter's EDF will be loaded into the flight MEU. Following Shuttle spaceflight of the SEM payload, the experiment hardware and emblem mount will be returned to the experimenter with a copy of the measurement data from the MEU.